ENERGY FACILITY SITE EVALUATION COUNCIL
STATE OF WASHINGTON

IN THE MATTER OF APPLICATION NO. 96-1 OLYMPIC PIPE LINE COMPANY CROSS CASCADE PIPE LINE PROJECT	APPLICATION NO. 96-1 PREFILED TESTIMONY OF JAMES B. THOMPSON EXHIBIT _____ (JBT-T) **ISSUE**: GEOTECHNICAL HAZARDS TO THE SNOQUALMIE TUNNEL **SPONSOR**: WASHINGTON STATE PARKS AND RECREATION COMMISSION

Q. Please provide your name and business address to the Council.

A. Name: James B. Thompson, Ph.D.
Principal

Business Address: Zipper Zeman Associates, Inc.
19231-36th Avenue West, Suite B201
Lynnwood, Washington 98036

Q. Please summarize your educational and employment background.

A. Educational Background:

Bachelor of Science in Civil Engineering from Cornell University in June 1967 with elective course work emphasis in geotechnical engineering and geology.

Master of Science in Civil Engineering from the University of California, Berkeley in June 1968 with an emphasis in geotechnical engineering.

Doctor of Philosophy from the University of California, Berkeley in June 1975. Major study area was geotechnical engineering and minor study areas included rock mechanics, ocean engineering, and business administration.

Employment Background:

October 1998 to present-Principal with Zipper Zeman Associates in Lynnwood, Washington. Geotechnical consulting services on a wide variety of projects.

November 1997 to October 1998-Principal with Icicle Creek Engineers, Inc. in Issaquah, Washington. Geotechnical consulting services on a large number on projects including 1) Puget Sound Energy reconstruction of a segment of the Electron Flume across a very steep bedrock mountainside and 2) Grays Harbor County North River Road realignment project which involved very deep bedrock excavations.

June 1995 to November 1997-Principal Geotechnical Engineer with Kleinfelder, Inc. in Bellevue, Washington. Geotechnical consulting services on a wide variety of projects.

May 1981 to June 1995-Project Engineer/Project Manager/Associate/Principal with GeoEngineers, Inc. in Redmond, Washington. Geotechnical consulting services on a large number of projects including 1) the Salish lodge which involved significant bedrock excavations and 2) Washington State Department of Transportation Selah-Yakima interconnect project which involved large bedrock excavations.

October 1979 to May 1981-Senior Engineer with Hart Crowser, Inc. in Seattle, Washington. Geotechnical consulting services on a wide variety of projects including

preparation of the earth and groundwater sections of the EFSEC DEIS for the proposed Trans Mountain oil pipeline project.

June 1975 to October 1979-Project Engineer with Earthtech in Long Beach, California. Geotechnical consulting services on many projects including the site characterization and evaluation studies for the U.S. Air Force MX missile project which included a large scale demonstration trench in very difficult ground conditions.

September 1968 to June 1975-Assistant Professor/Associate Professor/Professor with California State Polytechnic University in Pomona, California. Taught various civil engineering courses with an emphasis in geotechnical engineering.

June 1966 to September 1966-Staff Engineer with Mueser Rutledge Wentworth and Johnston in New York, New York. Worked primarily on the field exploration program for the Washington, D.C. rapid transit system.

June 1965 to September 1965-Staff Engineer with Tibbetts Abbott McCarthy Stratton in New York, New York. Worked on several geotechnical projects.

Q. Generally, what is the subject of your testimony?

A. My testimony deals with the identification and evaluation of potential geotechnical hazards to the existing Snoqualmie Tunnel on the Iron Horse State Park that may result from construction and operation of the proposed Olympic Pipe Line Company petroleum pipeline.

Q. Are you familiar with the proposal by the Applicant in this proceeding, Olympic Pipeline Company, to construct a petroleum pipeline in the Snoqualmie Tunnel?

A. Yes, the proposal is described in the sources of information outlined in the following response.

Q. What sources of information have you relied upon in preparing your testimony?

A. I have relied primarily on information from the following sources in preparing my testimony.

Written Documents:

- "Draft Environmental Impact Statement (DEIS), Cross Cascade Pipeline" dated September 1998.
- "Washington State Parks & Recreation Commission, Application for License, Permit or Easement", submitted by Olympic Pipe Line Company, dated November 13, 1998.
- Revised Application for Site Certification submitted to EFSEC by Olympic Pipe Line Company in May 1998.
- "Report, Geologic Engineering Evaluation, Trench Construction Feasibility Study, Snoqualmie Tunnel, Snoqualmie Pass, Washington, for Olympic Pipe Line Company", dated November 24, 1997, prepared by GeoEngineers, Inc.

Personal Communications:

- Telephone conversation with Tim Schmidt of Washington State Parks on January 19, 1999.
- Telephone conversation with Gordon Eastling of Olympic Pipe Line Company on January 21, 1999.
- Telephone conversation with Grant Bailey of Jones & Stokes on January 22, 1999.
- Telephone conversation with Brent Robertson of Trencor, Inc. on January 23, 1999.

- Telephone conversation with Richard Slade of Trencor, Inc. on January 24, 1999.
- Telephone conversation with Katey Chaney of Dames & Moore on January 26, 1999.
- Telephone conversation with Pat Butler of Washington State Parks on February 5, 1999.

Q. Have you had a chance to personally visit the Snoqualmie Tunnel?

A. No, because the tunnel is currently snowed in and there is an ice-fall hazard in the tunnel.

Q. Describe the Snoqualmie Tunnel?

A. A typical cross section of the tunnel is shown in Figure 2-6 of the DEIS. Quoting from the DEIS, "The Snoqualmie Tunnel was constructed between 1913 and 1915 by the CMSP&P Railroad and was in continuous service as a railroad tunnel into the 1970's. It was out of use until recently when it was opened to pedestrian, equestrian, and non-motorized vehicle use.

"The tunnel is approximately 3,627 m (11,900 feet) long and is mostly straight except for curves at the portals. Approximately the western 1.26 miles of the tunnel is along State Parks Lands while with the remaining eastern 1.01 miles of the route in the tunnel in on USFS Lands. The tunnel profile is a modified horseshoe shape with near-vertical sidewalls and a radius arch. It is entirely lined with reinforced concrete including concrete portal structures and headwalls at both portals. The tunnel has not been continuously maintained since the 1970's; however, the invert was graded and portions of the wooden drainage channel covers were replaced before it was reopened for recreational use.

"Dames & Moore personnel performed a site reconnaissance of the tunnel on July 30, 1997. They observed zones of concrete deterioration, seepage from construction joints, and cracks in the lining. Groundwater flows ranged from drips to flows through the

lining ranging from 3.8 to 7.6 liters (1 to 2 gallons) per minute. The concrete lining varied in condition from intact to spalled and decomposed as much as 0.3m (1 foot) behind the original finished face of the concrete . Reinforcing steel was exposed in some of the deeper spalled areas."

The GeoEngineers report dated November 24, 1997 states in part that "The walls and roof of the tunnel are covered by a concrete liner that was cast in place. Water seepage occurs sporadically from the walls and roof of the tunnel, through the concrete liner. The floor of the tunnel consists of medium dense to dense 5/8-minus crushed rock. Concrete-lined drainage channels are located at the base of the north and south walls along the entire length of the tunnel. The channels are covered by wood planks and synthetic fabric, apparently to minimize the collection of sediment. Water in the channels appears to flow toward the west."

Quoting further from the GeoEngineers report "An AT&T fiber optics cable is present approximately 0.5 foot north of the south drainage channel, based on utility locating activities completed for this project. A second fiber optics cable, owned by WorldCom, is generally located about 6.9 feet north of the south tunnel wall."

Continuing further from the GeoEngineers report " AT&T installed a fiber optics cable in 1989/90. This cable is protected within 5-inch-diameter steel drill pipe at a typical depth of about 12 inches (Figure 2). Construction of the WorldCom cable was recently completed. The WorldCom cable is protected within 2-inch-diameter black iron pipe at a typical depth of about 12 to 18 inches. The burial depth of the cable varies as a result of variations in the depth to bedrock. The WorldCom cable is located south of the

centerline throughout the entire length of the tunnel based on an agreement with Washington State Parks.

Ballast was encountered beneath the sand and gravel surface of the tunnel floor during installation of the fiber optics cables. The thickness of the ballast and overlying fill was reported to range from about 6 to 18 inches. Bedrock was encountered immediately below the ballast. Bedrock excavation was very difficult throughout the entire tunnel, becoming more difficult in the western portion of the tunnel."

The GeoEngineers report indicated that they received contradictory information regarding the techniques used for excavation in the tunnel. Quoting from the report, "Mr. Jones (with David Evans Associates) indicated that a backhoe and jackhammer were used for trenching inside the tunnel. Mr. Keierleber (with AT&T) and Mr. James (with WorldCom) indicated that cutting saws were used to make parallel deep cuts in bedrock in the tunnel. A jackhammer was then used to break out the bedrock around the saw cuts."

Mr. Tim Schmidt of Washington State Parks has indicated that the concrete scuppers and wood covers in the tunnel are in a fragile condition.

Ventilation within the tunnel is limited to the natural flow of air in and out of the portals.

Q. What is your understanding of the geologic conditions in the Snoqualmie Tunnel?

A. The GeoEngineers report dated November 24, 1997 states that " Most of the Snoqualmie Tunnel is located in bedrock identified as the Guye Sedimentary Member, based on a preliminary geologic map published by the U.S. Geological Survey (Open File map OF-84-693, 1984). The Guye Sedimentary Member is generally described as a light to dark

gray sandstone, slaty shale and chert-pebble conglomerate. The extreme western end of the tunnel is located in Mount Catherine Ryolite, according to the map. This Ryolite unit is described as being unusually hard, likely as a result of recrystallization during intrusion of the Snoqualmie batholith. The Guy Sedimentary Member is mapped as comprising the core of an anticline that generally trends north-south through the site vicinity. The tunnel extends through the axis of the anticline."

Quoting further from the GeoEngineers report " Fill is present on top of bedrock throughout the entire length of the tunnel. A surficial horizon of medium dense to dense 5/8-inch minus crushed rock (sand with silt and fine gravel) is present on the floor of the tunnel. The thickness of this unit varies from about 0.1 to 0.6 feet. Medium dense to dense sand and gravel units are present beneath the crushed rock. Ballast material associated with the former railroad is present on top of bedrock in each test pit. The ballast consists of dark gray fine to medium angular gravel with a trace of sand. The ballast aggregate consists of crystalline rock. The total thickness of the ballast and overlying fill ranged from about 0.6 to 2.1 feet in the test pits we observed, as shown in Figure 3.

"Bedrock lithologies in the tunnel generally trend from consolidated sedimentary rock (siltstone) to metamorphic rock (slaty shale and quartzite) as one travels from east to west."

Continuing from the GeoEngineers report "Slow to rapid groundwater seepage was encountered in most of the test pits, as summarized in Table 1. The ground water is generally perched in the railroad ballast on top of the bedrock. The depth to ground water seepage ranged from about 0.5 to 1.7 feet."

The GeoEngineers report goes on to say, “Using Schmidt hammer data, our estimates suggest compressive strength values ranging between about 3,000 and 22,000 psi (pounds per square inch) for the argillaceous siltstone present beneath the tunnel floor.” Further “We estimate that the average compressive strength of the quartzite is about 35,000 psi, based our tests.”

The GeoEngineers report concludes that “The results of our evaluation indicate that it will likely be necessary to excavate very dense bedrock throughout the entire length of tunnel to install the proposed products pipeline. Bedrock was encountered at depths ranging from about 0.6 to 2.1 feet below the tunnel floor in the test pits we completed. We anticipate that bedrock with a compressive strength exceeding about 20,000 psi will be very difficult to excavate using conventional trenching equipment. In our opinion, it will likely be feasible to excavate bedrock with a compressive strength ranging between about 10,000 and 20,000 psi using the same equipment. We anticipate that bedrock with a compressive strength less than about 10,000 psi may be excavated in a relatively routine fashion with equipment designed for rock excavation.

“Based on our widely spaced explorations, we anticipate that excavation difficulty will increase in the approximately western 4,000 feet of the tunnel (west of TP-14) because bedrock is anticipated to consist predominantly of quartzite in this area. Bedrock excavation was reported to be more difficult in the western portion of the tunnel during installation of the AT&T and WorldCom fiber optic cables. The likely presence of ground water seepage from the overburden (ballast) should be considered during the selection of excavation equipment for this project.”

Q. Please provide a description of your understanding of the construction approach proposed by the Applicant for the pipeline in the Snoqualmie Tunnel.

A. The tunnel cross section shown in Figure 2-6 of the DEIS indicates that the 14-inch diameter petroleum pipeline will be buried in a trench excavated in the floor of the tunnel. The centerline of the petroleum pipeline will be located 18 inches north of the tunnel centerline. The trench will be 24 inches wide and on the order of 40 inches deep. After installing the petroleum pipeline, the trench will be backfilled with select backfill and capped with 2-inches of lean concrete. A 6-to 8- inch layer of ballast will subsequently be placed on the floor of the tunnel.

The above-referenced "Application for License, Permit or Easement" provides the most complete description of the construction approach proposed by Olympic Pipe Line Company for the pipeline in the Snoqualmie Tunnel. The following is a partial summary of the construction sequence described in that document.

<u>Ditching</u>

- Initial excavation of the first 6" of sand and ballast material will be removed from the trench line and if adequate space is available, stored against the south wall. If space is not adequate, the spoil will be moved by truck to a satisfactory location.

- Once all sand and ballast is removed, rock cutting equipment will cut a trench in the rock approximately 24" wide and 36" inches deep through the tunnel. The centerline of the trench will be located 6 feet from the north wall. This trench will be located on the opposite side of the centerline where AT&T and WorldCom have buried facilities.

- Spoil from rock trenching will be removed from the tunnel and relocated by truck to a satisfactory location.

- All spoil material could be removed from the tunnel by a conveyor system.

- If blasting is required, an approved plan will be submitted by a qualified and licensed blasting contractor. This contractor will submit an approved comprehensive site specific safety plan to the Project Safety Engineer and will coordinate any blasting activity with OPL, State Parks and any applicable regulatory agency.

Backfilling

- The trench will be backfilled and compacted with 1"minus granular material up to a depth approximately 2" below the top of rock formation. The remaining 2" will be filled with a lean concrete mix, being a maximum of 2000 psi.

- The sand and ballast will be replaced and compacted to standard requirements.

Compliance

- All excavation in the Snoqualmie Tunnel will be coordinated and monitored by a geologist or engineer to verify proper excavation methods are used.

- All construction activity in the Snoqualmie Tunnel will be coordinated and monitored by a full-time environmental compliance coordinator to ensure environmental "best management practices" are used.

Restoration

- The tunnel floor will be restored and improved in accordance with State Parks specifications.

The "Application for License , Permit or Easement" indicates in general terms that shaped charges are used where blasting is required, to limit the amount of outward explosion. Also, heavy blasting mats are placed over the charge to limit the amount of debris spread and reduce noise impacts.

The application does not describe the specific rock cutting equipment which will be used to excavate the pipeline trench or provide any information on the degree to which blasting will be required to excavate the trench.

Mr. Gordon Eastling of Olympic Pipeline Company confirmed during our telephone conversation on January 21, 1999 that the general plan at the present time is to use mechanical rock cutting equipment to the maximum extent possible. However, controlled blasting may be used where the bedrock conditions are not suitable for rock cutting.

It is my general impression at this time that although some work has been done to characterize the geologic conditions in the tunnel, only limited thought has been given to the details of the construction approach which will be used in the tunnel. Furthermore, it appears that only a limited amount of work has been completed to confirm that the proposed construction approach is feasible from both a technical and economic viewpoint without adversely impacting the tunnel.

Q. Do you believe that construction of the pipeline, as proposed, could have adverse impacts on the Snoqualmie Tunnel?

A. In my opinion, potential construction related impacts to the tunnel could include the following:

Damage to Concrete Walls and Roof of Tunnel:

The rock cutting equipment used to excavate the trench may subject the concrete walls and roof of the tunnel to significant vibrations (or air blasts in the case of blasting), particularly since the bedrock in the floor of the tunnel is described as being very strong. Portions of the concrete roof and walls of the tunnel are deteriorated. Excessive vibrations (and air blasts in the case of blasting) could result in damage to the structural integrity of the concrete roof and walls of the tunnel. Related effects could include a reduction in the integrity of the bedrock behind the concrete walls and roof, increasing the number of locations at which groundwater seepage is occurring through the concrete walls and roof, and increasing the seepage rates at existing locations.

Damage to Existing AT&T and WorldCom Fiber Optics Cables:

The petroleum pipeline will be constructed within a few feet of the existing AT&T and WorldCom fiber optics cables. These cables could be damaged during pipeline construction as a result of direct impacts by construction equipment or by vibrations caused by construction. As a side effect, the tunnel may have to be closed for a period of time to repair any damage.

Damage to Existing Concrete Drainage Scuppers and Wood Covers:

Portions of the existing concrete drainage scuppers are in a fragile condition and the existing scuppers have wood covers. It is likely that the wood covers will be heavily damaged by construction activities in the tunnel. Also, portions of the existing concrete drainage scuppers may be damaged.

Restrictions on Use of Tunnel by Public:

Access for construction equipment both to and within the tunnel is very limited. It is likely that the tunnel will have to be closed for use by the public when the pipeline is being constructed in the tunnel.

Loss of Crushed Rock Surface:

An existing zone of crushed rock has been placed on the floor of the tunnel to act as a "running surface" for pedestrian, equestrian, and non-motorized vehicle traffic. The existing crushed rock surface will be lost as a result of pipeline construction and it is important that it be replaced. A significant fall hazard could exist in the unlighted tunnel without the crushed rock "running surface", particularly if cobbles and boulders are exposed on the surface.

Hazards to Construction Personnel:

Construction personnel will be exposed to a number of potential hazards including concrete spalls, rock falls, ice falls, and exhaust fumes.

Q. Is there anything Olympic Pipeline Company should do to confirm that the proposed construction approach in the Snoqualmie tunnel is feasible?

A. As mentioned above, it is my general impression that only limited thought has been given to the details of the construction approach which will be used in the tunnel. Furthermore, it appears that only a limited amount of work has been completed to confirm that the proposed construction approach is feasible from both a technical and economic viewpoint without impacting the tunnel.

In my opinion, Olympic Pipe Line Company should prepare a detailed plan for construction of the pipeline within the tunnel. The proposal should include a detailed description of the proposed methods and equipment, with supporting information to confirm the suitability of these methods and equipment with respect to site specific conditions. This is a particularly critical issue because the pipeline trench in the floor of the tunnel is expected to encounter very dense bedrock, including quartzite, which will be difficult to excavate. Also, access to and within the tunnel is very restricted.

Further, it is my opinion that Olympic Pipe Line Company should complete a thorough evaluation of the structural integrity of the concrete roof and walls of the existing tunnel. Olympic Pipe Line Company should use this information along with the details of the proposed construction approach to thoroughly evaluate the potential effects of pipeline construction on the tunnel.

The detailed construction plan, results of the structural evaluation, and evaluation of potential effects on the tunnel should be submitted to Washington State Parks and other interested parties for review and comment.

Q. Is there anything Olympic Pipeline Company could or should be required to do to eliminate these potential construction impacts?

A. Possible mitigation measures that could be taken during construction are listed below. These measures are keyed to the potential impacts listed above.

Damage to Concrete Walls and Roof of Tunnel:

The following measures could be taken to address the potential for damage to the structural integrity of the concrete roof and walls of the tunnel as well as related impacts such as a reduction in the integrity of the bedrock behind the concrete walls and roof, an increase in the number of locations at which groundwater seepage is occurring through the concrete walls and roof, and an increase in the seepage rates at existing locations.

- Olympic Pipe Line Company should use construction methods and equipment which have been demonstrated to be technically and economically feasible, and not likely to adversely impact the tunnel.

- The use of blasting within the tunnel should be prohibited or severely limited. Excessive ground vibrations and air blasts from blasting could damage the tunnel.

- As mentioned above, Olympic Pipe Line Company should complete evaluations of the structural integrity of the concrete walls and roof, and the floor of the tunnel. In

my opinion, structural evaluations should be made prior to, during, and following completion of construction.

- The vibration levels which could damage the tunnel should be established for the various types of construction equipment. Limits should be placed on the maximum vibration levels which will be acceptable in the tunnel during construction.

- Complete evaluations of the locations and rates at which seepage is occurring through the concrete walls and roof. These evaluations should be completed both before and after construction.

- Establish a suitable monitoring program for construction. This monitoring program should include both visual observations as well as monitoring of the vibration levels induced in the concrete walls and roof by pipeline construction.

- Establish a short test section for the proposed construction methods and equipment within the tunnel. This test section would be used to evaluate the actual construction impacts on a short section of the tunnel, and to provide information for use in evaluating the feasibility of the construction approach or modifying the details of the construction approach as necessary.

- Olympic Pipe Line Company should be held responsible for repair of any damage to the tunnel caused by pipeline construction.

<u>Damage to Existing AT&T and WorldCom Fiber Optics Cables:</u>

Suggest that AT&T and WorldCom complete a review of the proposed construction and provide comments on the likely impacts of pipeline construction within the tunnel on the existing fiber optics cables. I understand that both AT&T and WorldCom are reportedly extremely concerned about the proposed pipeline project. Some areas of concern include uncertainties regarding the exact location the existing fiber optics cables in the tunnel and the potential effects of cathodic protection on the fiber optics cables.

Damage to Existing Concrete Drainage Scuppers and Wood Covers:

As mentioned above, it is likely that all or most of the existing wood covers will be damaged. Olympic Pipe Line Company should replace the wood covers as well as repair or replace any of the concrete scuppers which are damaged by pipeline construction.

Restrictions on Use of Tunnel by Public:

The following measures could be taken to mitigate restrictions on the use of the tunnel by the public.

- Schedule pipeline construction for periods when the tunnel is closed or only lightly used by the public.

- Utilize construction techniques and equipment which will minimize the amount of time the tunnel is closed for pipeline construction.

- The "Application for License , Permit or Easement" states that construction in the tunnel is scheduled for the 4th Quarter of the year 2000. This schedule will tend to

mitigate potential impacts on use of the tunnel by the public. Olympic Pipe Line Company should be required to specify and adhere to fixed dates for construction of the pipeline in the tunnel.

Loss of Crushed Rock Surface:

As indicated in the proposal by the applicant, Olympic Pipeline Company should be required to replace the existing crushed rock "running surface" with a new zone of crushed rock at the completion of construction.

Hazards to Construction Personnel:

As indicated in the proposal by the applicant, Olympic Pipeline Company should be required to provide appropriate protection for personnel during construction.

General:

It may be necessary to consider an alternate pipeline route other than through the Snoqualmie Tunnel in the event pipeline construction through the tunnel is not feasible.

Q. Do you believe that the pipeline, as proposed, could have adverse impacts on the Snoqualmie Tunnel during post-construction operation of the pipeline?

A. In my opinion, potential post-construction related impacts to the tunnel could include the following.

Long-Term Effects on Integrity of Tunnel:

It is possible that long-term effects on the integrity of the tunnel that are not noticed or detected during construction could develop over time. These impacts could include a reduction in the integrity of the bedrock, concrete walls and roof of the tunnel. Related effects could include an increase in the number of locations at which groundwater seepage is occurring through the concrete walls and roof, and an increase in seepage rates at existing locations.

Leaks from Pipeline:

It is conceivable that leaks could develop from the petroleum pipeline within the tunnel. Depending on the severity of the leak and the amount of time before detection, this may result in the development of hazardous petroleum vapors within the tunnel and/or contamination of the soil and bedrock which form the tunnel floor. Leakage may also result in closure of the tunnel for a significant period of time to make repairs and clean up the spill.

Modifications to Drainage Conditions in Tunnel:

Construction of the pipeline may result in significant modifications to the drainage conditions in the bottom of the tunnel. This could cause portions of the tunnel bottom to become wet and soft, and also possibly impact the stability of steep slopes adjacent to the tunnel portals if water collected in the tunnel is allowed to drain toward these slopes.

Restrictions on Use of Tunnel by Other Future Facilities:

The petroleum pipeline will be located close to the tunnel centerline. Furthermore, the "Application for License , Permit or Easement" appears to indicate the Olympic Pipe Line Company is requesting a 10 foot permanent easement in the tunnel. The presence of the pipeline in the floor of the tunnel may result in restrictions on the use of the tunnel by others for installation of future communication cables, pipelines, etc.

Q. Is there anything Olympic Pipeline Company could or should be required to do to eliminate these potential post-construction impacts?

A. Possible mitigation measures that could be taken post-construction are listed below. These measures are keyed to the potential impacts described above.

Long-Term Effects on Integrity of Tunnel:

Olympic Pipe Line Company and Washington State Parks should monitor the future performance of the tunnel. Olympic Pipe Line Company should be required to assume responsibility for the following, to the extent that they are associated with construction of the pipeline: 1) future repairs to the tunnel and 2) claims for personal injury and property damage by those who use the trail.

Leaks from Pipeline:

A number of steps could be taken to minimize the risk of leaks from the petroleum pipeline in the tunnel or mitigate these potential impacts, including the following:

- Hydrostatic tests should be run for the pipe in the tunnel twice, as planned for critical river crossings, to achieve a higher degree of confidence that there are no leaks in the pipeline prior to burial.

- A special design should be developed for the pipeline trench within the tunnel that will allow the collection and easy detection of leakage from the pipe, perhaps in a series of sumps installed along the pipeline.

- An evaluation should be made of the feasibility of installing a vapor monitoring and warning system to detect hazardous petroleum vapors within the tunnel.

- An evaluation should be made of the merits of installing block valves in close proximity to the tunnel portals to limit the amount of product available to feed a spill.

- An evaluation should be made of the merits of using a greater wall thickness for the pipe in the tunnel to provide a stronger pipe.

- Consideration should be given to using a double-wall pipe within the tunnel to provide a means of collecting leakage from the inner pipe.

<u>Modifications to Drainage Conditions in Tunnel:</u>

An evaluation should be made of the existing drainage conditions within the soil and bedrock in the floor of the tunnel. The potential effects of the pipeline trench on these drainage conditions should be determined and a design should be developed to mitigate these effects.

Restrictions on Use of Tunnel by Other Future Facilities:

Develop a comprehensive plan for possible future use of the Snoqualmie Tunnel by others. Incorporate the Olympic Pipeline proposal into this plan and establish appropriate limits for the permanent right of way for the pipeline. Perhaps, the construction of some form of utilidor that is capable of housing multiple facilities should be considered for the tunnel.

DATED this _____ day of February, 1999.

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JAMES B. THOMPSON